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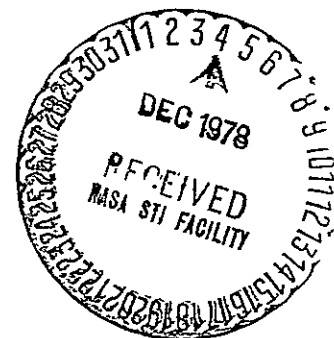
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LARGE AREA CROP INVENTORY EXPERIMENT (LACIE)

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NASA NOAA USDA

Level 3 Baseline

LACIE OPERATIONS PLAN



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National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER

Houston, Texas

July 11, 1975

NOTE

This document is being published with the following known deficiencies which will be corrected in the next update to the document:

- Predicted acquisitions of data
- List of sample segments by country
- Description of electronic storage and retrieval
- Updated figure 1-2 of the LACIE integrated Applications Evaluation System

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GLOSSARY

ADP	Automatic Data Processing
AES	Applications Evaluation System
AI	Analyst Interpreter and Interpretation
ASVB	Application Systems Verification Branch
CAMS	Classification and Mensuration Subsystem
C&I	Composition and Indexing
CAS	Crop Assessment Subsystem
CCB	Configuration Control Board
CCEA	Center for Climate and Environmental Assessment
CCT	Computer Compatible Tape
COMF	Computer Output Microfiche Facility
CRD	Crop Reporting District
DAPTS	Data Acquisition, Preprocessing, and Transmission Subsystem
DDC	Data Distribution Center
DM	Data Management
DPA	Data Processing Analyst
DPCA	Data Production Control Analyst
DPR	Data Processing Request (form)
DR	Discrepancy Report
DSAD	Data Systems and Analysis Directorate
EOD	Earth Observations Division
ERIPS	Earth Resources Image Processing System

ERPO	Earth Resources Program Office
ERTS	Earth Resources Technology Satellite
ESATS	EOD Status and Tracking System
FAS	Foreign Agricultural Service
FDC	Federal Data Center
FSO	Facilities Support Office
GDSD	Ground Data Systems Division
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
IDSD	Institutional Data Systems Division
IE	Information Evaluation
ISATS	Interim Status and Tracking System
ISRRS	Information Storage, Retrieval and Reformatting Subsystem
ITS	Intensive Test Site
JSC	Lyndon B. Johnson Space Center
LACIE	Large Area Crop Inventory Experiment
LANDSAT	Land Satellite (formerly ERTS)
LDSS	LACIE Data Systems Supervisor
LOS	LACIE Operations Supervisor
LPDL	LACIE Physical Data Library
MLA	Mean Level Adjustment
MPAD	Mission Planning and Analysis Division
MSS	Multispectral Scanner
NASA	National Aeronautics and Space Administration

NDPF	NASA Data Processing Facility (GSFC)
NMC	National Meteorological Center
NOAA	National Oceanic and Atmospheric Administration
NTTF	Network Test and Training Facility (GSFC)
OCC	Operations Coordination Center (JSC)
OCC	Operations Control Center (GSFC)
PFC	Production Film Converter
PFS	Production Film System
PI	Photointerpreter and Photointerpretation
PMT	Project Management Team
PPS	Probability Proportional to Size
PTD	Photographic Technology Division
PTL	Photographic Technology Laboratory
QA	Quality Assurance
RT&E	Research, Test, and Evaluation
RTCC	Real-time Computer Complex
SPE-EA	System Performance Evaluation - Efficiency Analysis
SPE-RI	System Performance Evaluation - Reports Integration
SRS	Statistical Reporting Service
T&E	Test and Evaluation
USDA	U.S. Department of Agriculture
WMO	World Meteorological Organization
YES	Yield Estimation Subsystem

1.0 INTRODUCTION

1.1 PURPOSE

This document delineates the Large Area Crop Inventory Experiment (LACIE) operational approach, the operational and organizational requirements, and the responsibilities necessary for meeting the LACIE objectives by the participating organizations: National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA), and U.S. Department of Agriculture (USDA).

1.2 SCOPE

This document controls those operations and responsibilities that are under the jurisdiction of the LACIE Manager and the Level III Configuration Control Board (CCB).

Included in the scope of this plan are sample segment definition and selection, data acquisition, preprocessing and transmission, classification and mensuration of wheat, and crop aggregations. The basis for development of organizational interface control documentation and for detailed operational procedures and information flow in the LACIE Data Handling and Procedures Document is found herein.

As LACIE computer system power, analytical technology, and global concentration expand, operational capabilities will concurrently increase. Each new capability will rest upon sound operational experience and give rise to new related capabilities accompanied by their sets of requirements, milestones, and refinements -- all of which will be integrated into this plan in a time-phase manner.

1.3 DESCRIPTION OF LACIE

1.3.1 LACIE Overview

The LACIE is a demonstration of the capabilities of an Earth resources survey system to provide an agricultural

crop assessment in a timely manner. It is an interagency project involving the USDA, NOAA, and NASA. The LACIE will utilize the Land Satellite (LANDSAT¹) multispectral scanner (MSS) data, satellite-derived and ground-measured meteorological information, and historical data. These inputs will be combined in the system that will be developed to handle, process, and analyze the data for determining periodically throughout the growing season the production of an agricultural crop on a country-by-country basis. The test crop for LACIE is wheat, and the demonstration will run over a 3-1/2-year period. The system ultimately will estimate crop area and crop yield and combine these two parameters to arrive at crop production. The project will also assess the resources required to achieve these results and the accuracy of the information produced. The LACIE Schedule Level 1 (fig. 1-1) provides an overview of the LACIE development. Section 5.0 of this document provides an overview of the LACIE data flow.

1.3.2 LACIE Phase Definition

1.3.2.1 Phase I. The Phase I operations analysis will occur during the period from November 1, 1974, through September 30, 1975. During this period the area of U.S. Hard Red and Durum wheat will be estimated in the U.S. Great Plains (Montana, Texas, Colorado, Kansas, Minnesota, North Dakota, South Dakota, Oklahoma, and Nebraska). Other selected areas in the United States will also be studied as will selected areas in the countries of U.S.S.R., China, Canada, India, Australia, Brazil, and Argentina according to the priorities specified in section 3.2.1.1. Phase I is divided into three subphases which are listed in the following sections.

1.3.2.1.1 Phase IA: Phase IA starts on November 1, 1974, and utilizes the LACIE 1 Automatic Data Processing (ADP) system. System startup and checkout will be performed during November and December. During this period, retrospective LANDSAT-1 data from selected sites in Kansas for the 1973-74 crop year will be utilized and processed. Classification, including local recognition and manual signature extension,

¹The Earth Resources Technology Satellite (ERTS) was renamed LANDSAT in January 1975.

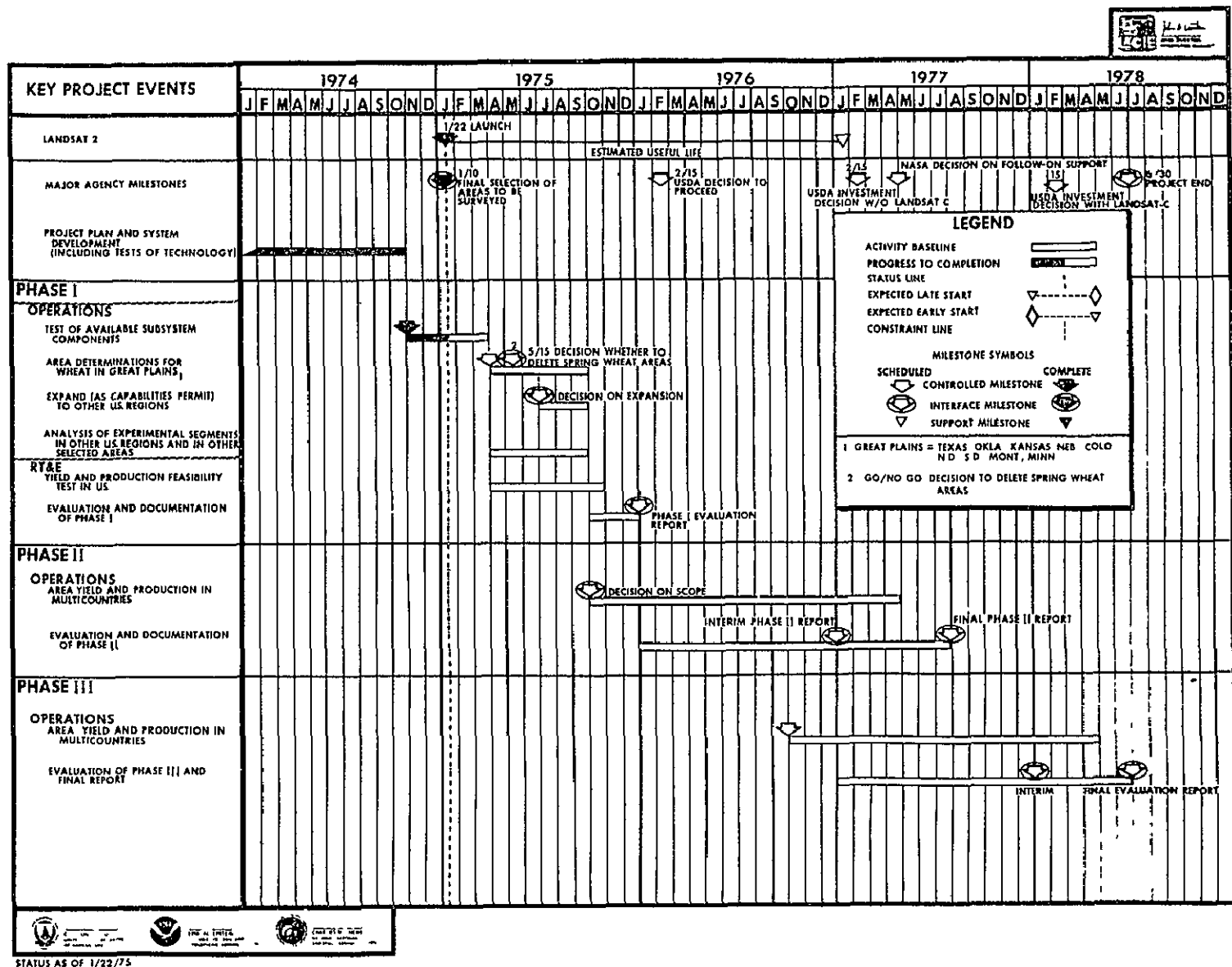


Figure 1-1. - LACIE schedule level 1.

will be tested and the results checked on the basis of the ground truth data. This phase ends with the completion of processing of this data.

1.3.2.1.2 Phase IB: Phase IB begins in January 1975 with the processing of data at rates of up to 7 to 11 sample segments per day. These include the first biological phase for 266 winter wheat and 145 spring wheat sample segments acquired over the U.S. Great Plains for the 1974-75 growing season. Predicated on evaluation results and acquisition limitations of LANDSAT, this operation will then be extended to provide wheat acreage estimates over the remaining LACIE areas. Area determinations of spring and winter wheat will be made for the entire 1974-75 crop year.

1.3.2.1.3 Phase IC: This phase will be conducted from April 1, 1975, through the end of September 1975. The data system at NASA's Lyndon B. Johnson Space Center (JSC) will be upgraded with the LACIE 2 ADP system before this phase starts. During this period, data are scheduled to be processed at a rate of up to 15 to 20 sample segments per day.

1.3.2.2 Phase II. Phase II operations analysis will cover the period from October 1, 1975, through May 1, 1977. During Phase II, the system will perform area aggregation, yield aggregation, and production estimation in multicountry areas and exercise the system in a full-up operational environment. From October through December 1975, data will be processed at rates of up to 15 to 20 sample segments per day. A special-purpose hardware processor will be added to the data system and will be operational on January 1, 1976, after which the processing rate will increase up to 30 sample segments per day.

1.3.2.3 Phase III. Phase III operations analysis begins on October 1, 1976, and continues to May 1, 1978, which overlaps Phase II. During this period the system will perform area aggregation, yield aggregation, and production estimation in multicountries. As a result of the operational experience gained during Phase II, it is anticipated that the processing rate will increase up to 40 sample segments per day during this phase.

1.4 APPLICATIONS EVALUATION SYSTEM (AES) DESIGN CONFIGURATION

The LACIE integrated AES, as shown in figure 1-2, depicts the relationships, staff interface, data flow and interfaces, and the systems involved in the integrated non-ADP and ADP data system.

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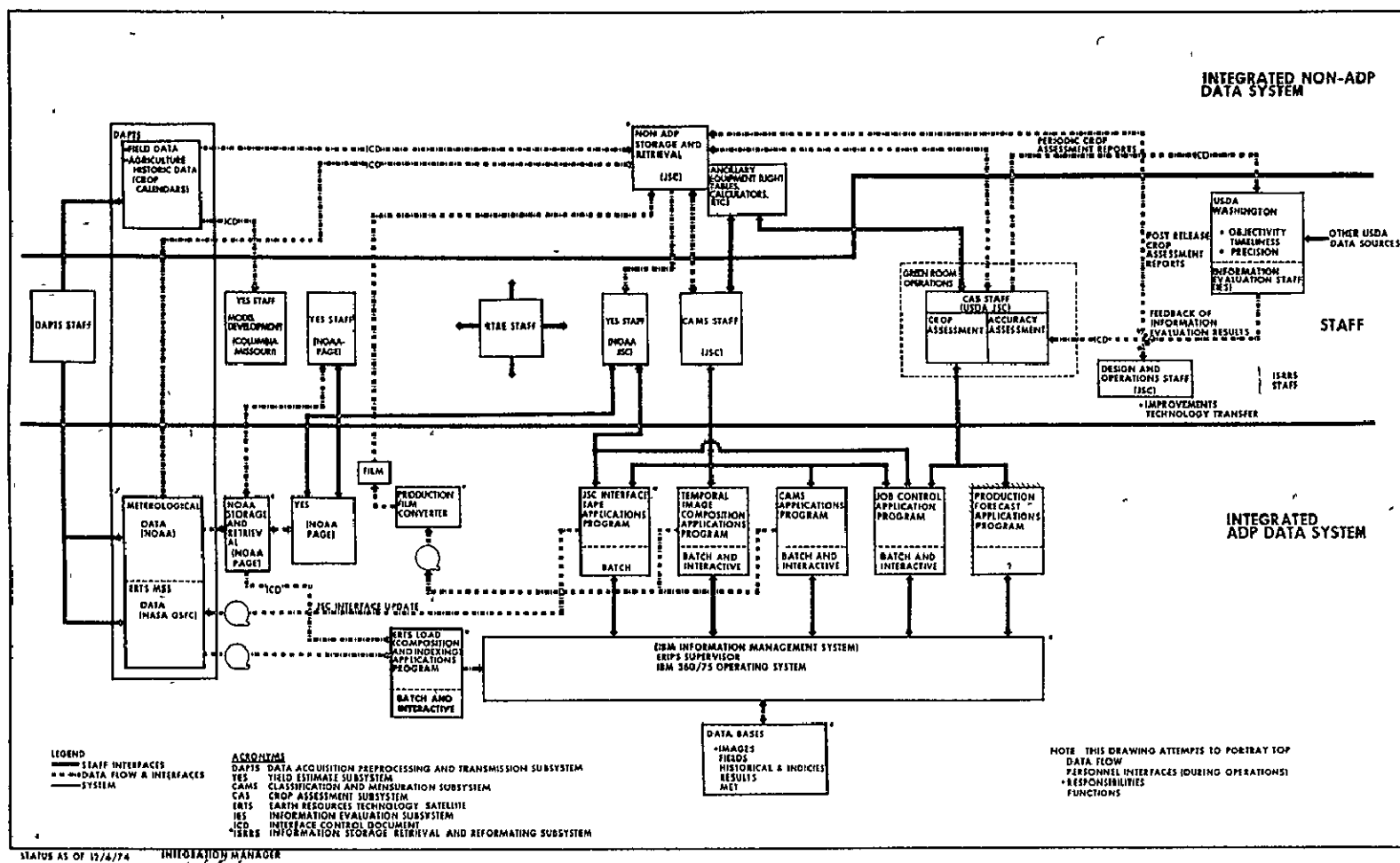


Figure 1-2. — LACIE integrated applications evaluation system.

2.0 LACIE OPERATIONAL OBJECTIVES

2.1 PHASE I OBJECTIVES

2.1.1 General Objectives

2.1.1.1 Primary operational objectives.

1. Provide from an analysis of LANDSAT data acquired over a sample of the crop producing area of the U.S. Great Plains estimates of the area planted to wheat.
2. Evaluate the capability to perform an analysis of the sample data no later than 14 days after their acquisition by LANDSAT.
3. Perform an assessment of the accuracy and reliability of the results of the above area estimation.
4. Evaluate the results of the area estimate as to objectivity, utility, and timeliness.
5. Evaluate the capability for expansion to the other major wheat-growing regions.

2.1.1.2 Secondary operational objectives.

1. Evaluate the performance of the AES from an efficiency and cost viewpoint.
2. Provide guidance and support to the ongoing research, periodic review of efforts, and test and evaluation (T&E) program and achieve maximum utilization of Research, Test, and Evaluation (RT&E) results.

2.1.2 Subobjectives

2.1.2.1 Data Acquisition, Preprocessing, and Transmission Subsystem (DAPTS). The objectives of the DAPTS are to:

1. Coordinate, collect, and acquire all the data necessary to meet the data requirements of the other subsystems. These subsystems will define the data categories that DAPTS will acquire as well as its quality, quantity, frequency, and temporal characteristics.
2. Preprocess and transmit to Information Storage, Retrieval, and Reformatting Subsystem (ISRRS) all data common to AES and RT&E.
3. Acquire preprocessed MSS and real-time meteorological data from outside centers.
4. Preprocess field data, historic agricultural and meteorological data, and aircraft data.

2.1.2.2 Information Storage, Retrieval, and Reformatting Subsystem (ISRRS). The objectives of the ISRRS are to:

1. Validate the quality and timeliness of imagery production and distribution.
2. Determine the limitation on the production film converter (PFC) throughput capability.
3. Verify that disk-based mass storage can reasonably be used to provide storage and retrieval of electronic data.
4. Determine the degree to which it is possible to track ISRRS disk data base operations, including updates, purges, and integrity maintenance.
5. Verify that a manual directory maintenance function can maintain an awareness of system data flow through the ISRRS.
6. Verify that the Ground Data Systems Division (GDSD) tracking and status system can interface with the manual directory.

7. Verify that the physical library can manually maintain files of historical data, imagery, and reports and that the data can be logged and distributed to the users.

2.1.2.3 Classification and Mensuration Subsystem (CAMS).
The objectives of CAMS are to:

1. Obtain classification results and Analyst Interpreter (AI) field interpretations in support of acreage estimation, accuracy assessment, and T&E.
2. Evaluate classification results in support of accuracy assessment and T&E.
3. Conduct all operations in a manner supporting expansion to 4,800 segments.
4. Develop and test logistics and procedures, including data processing analyst (DPA) interface for processing data through CAMS.
5. Develop and test CAMS batch, terminal, and evaluation procedures.
6. Develop and test AI procedures, with particular emphasis on foreign exploratory segments.
7. Train and certify analysts and operations personnel.
8. Develop and test signature extension procedures.

2.1.2.4 Yield Estimation Subsystem (YES). The YES objectives are to:

1. Select, redesign, implement, and operate agro-met models for selected areas to obtain yield estimates for the RT&E effort.
2. Provide to other subsystems meteorological data summaries and crop calendar variations.
3. Test and evaluate agro-met modeling procedures to be implemented during Phase II.

4. Test and evaluate crop calendar variation models to be implemented in Phase II.

2.1.2.5 Crop Assessment Subsystem (CAS). The CAS objectives during Phase I are to:

1. Make wheat area estimates (for spring, winter, and total wheat) in the U.S. Great Plains and determine the statistical reliability of this estimate.
2. Monitor a CAMS determination of the accuracy of the AI, DPA, and signature extension procedures.
3. Determine the aggregation errors for the area estimates.
4. Evaluate the interaction of Information Evaluation (IE) and CAS by transmitting CAS wheat area reports to IE and receiving IE feedback.
5. Evaluate the interface of YES and CAS in selected U.S. areas in a test mode.
6. Evaluate the interface of YES and CAS in selected foreign areas in a test mode.
7. Produce yield and production reports for selected U.S. areas on a test basis.
8. Define and develop procedures for dealing with episodal events such as severe drought, winter-kill, etc.

2.1.2.6 The System Performance Evaluation - Efficiency Analysis (SPE-EA). Objectives are to monitor the LACIE I operations in order to obtain, record, and report data relating to the operating efficiency of the system with respect to available resources. Data to be collected for all operational subsystems are manpower, data throughput and material, equipment, and computer usage. The SPE-EA will produce monthly resource utilization reports to provide management information leading toward improved system design and operation, to provide baseline information for the LACIE simulation program, and to document for historical purposes the system operating efficiency.

2.1.2.7 Information Evaluation (IE). The accomplishment of an evaluation of the timeliness and utility of area information produced within the LACIE AES is the objective of IE.

2.2 PHASE II OBJECTIVES

To be supplied.

2.3 PHASE III OBJECTIVES

To be supplied.

3.0 OPERATIONAL APPROACH

3.1 GENERAL

Sample segments will be selected and ordered in a manner to support the LACIE objectives. The method of selecting and ordering the segments and the approach and plan for processing the data are presented in this section.

3.1.1 Sample Segment Selection

The initial sample segment allocation to eight countries is made on the basis of the proportion of wheat area contained within a country to the total wheat area in all LACIE countries. Due to system limitations, the total number of sample segments available for allocation is 4,800. These segments are allocated as follows:

<u>Country</u>	<u>Total</u>	<u>Winter wheat</u>	<u>Spring wheat</u>
Argentina	165	165	—
Australia	257	257	—
Brazil	50	50	—
Canada	283	—	283
China	810	594	216
India	626	626	—
U.S.	637	485	152
U.S.S.R.	1,949	567	1,382

The sample segments allocated to a country are further allocated to the smallest political subdivision of the country for which agricultural statistics are available. The number of sample segments allocated to the lower level is made in proportion to the ratio of wheat area to the total area contained in that political subdivision.

The segments are then randomly located in the agricultural area (nonagricultural area is eliminated in the location process) of the political subdivision in accordance with the following LANDSAT frame constraints:

1. All sample segments must fall within the center 80 n. mi. of the frame (i.e., 10 n. mi. on the east and west sides of the frame are restricted).
2. A maximum of four segments may occur in the east/west direction on any given 80 × 100 n. mi. frame area.
3. Sample centers must be separated by 11 n. mi. in the east/west direction.
4. A maximum of eight sample segments may occur in the north/south direction on any given 80 × 100 n. mi. frame area.
5. The sample segment centers must be separated by 10.5 n. mi. in the north/south direction.
6. A maximum of 4,800 segments four times a year may be stored.

If a segment violates any constraints, another segment location is randomly selected. This process is continued until all allocated samples are located.

3.1.2 Sample Segment Maps

CAS will plot the sample segment locations on country maps which will be available for use in analyzing and processing LACIE data by the AES.

3.1.3 Biological Window Definition

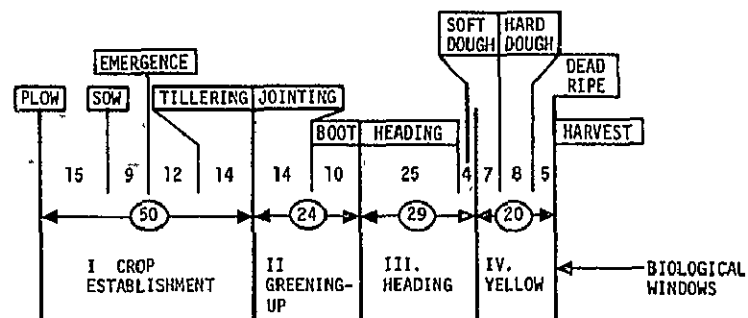
There are several forms of the biological window definition (see table 3-I and figure 3-1) which will be generated by YES and utilized by YES, DAPTS, CAMS, and CAS during Phase I operations, which are as follows.

TABLE 3-I. - DEFINITIONS OF DEVELOPMENT STAGES AND BIOLOGICAL
WINDOWS FOR WHEAT

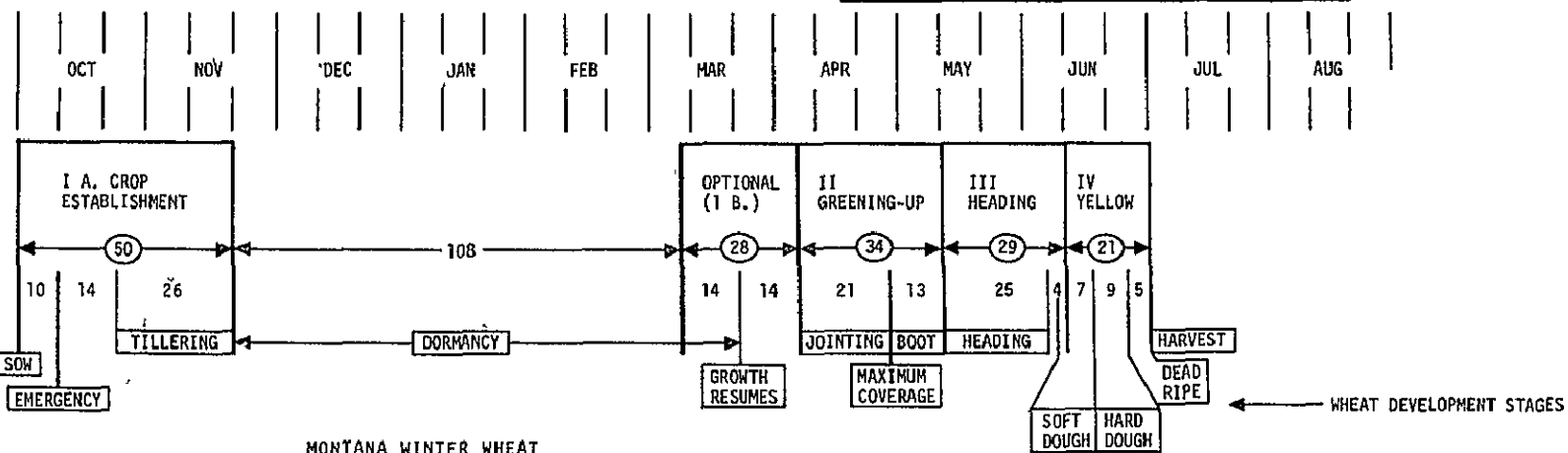
[A stage is said to begin when 50% of each crop and 50% of the
wheat in that area have reached the described development]

Biological window	Stage name	Other common stage name	Definition of beginning of stage
1. Crop establishment	Plowing	Seedbed preparation	Field is being plowed.
	Sowing	Planting	Seed is in ground.
	Emergence	Sprouting	The first leaf has formed above the soil surface.
	Tillering	Stooling	Additional shoots or leaves (2 to 6 tillers) have emerged above ground.
	Dormancy	Vegetation stops	The plant stops developing and may die back.
	Spring growth	Spring renew	Winter wheat only When the average daily maximum temperature reaches about 42° F the plant begins to grow again.
2. Greening-up	Jointing	Stem elongation	The stalks start elongating between joints. Joints can easily be seen. Ground cover is about 20-25%.
	Booting	Ear formation	The head within the leaf sheath below the top foliage leaf begins to swell. Ground cover is at its maximum.
3. Heading	Heading	Heads emerging	The head has emerged from the leaf sheath.
4. Yellow	Soft dough	Waxy ripe or intermediate maturity	Kernels in the head squeeze easily, feel plastic or pliable and may exude some milky fluid.
	Hard dough	Mealy ripe	Kernels are firm and may be dented with the fingernail, but are not easily crushed.
	Dead ripe	Ripe	Kernel is hard and breaks in fragments when crushed.
	Harvest		Grain is being combined or swathed.

MONTANA SPRING WHEAT



HISTORICALLY AVERAGED CROP CALENDAR



MONTANA WINTER WHEAT

A STAGE IS SAID TO BEGIN WHEN 50% OF EACH CROP AND 50% OF THE WHEAT IN THAT AREA HAVE REACHED THE DESCRIBED DEVELOPMENT

Figure 3-1. — Example LACIE biological windows for wheat

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3.1.3.1 Biological window definition. Biological windows have been defined and computed at the Crop Reporting District (CRD) level for the United States, the Census Division level for Canada, along the Isochronological lines for Argentina, the Oblast level for the U.S.S.R., the Province level for China, and the state level for India, Australia, and Brazil. The individual biological windows have been defined as follows for winter wheat:

- a. Biowindow I - Crop Establishment
 - 1. Biowindow IA - From sowing to beginning of dormancy
 - 2. Biowindow IB - From 2 weeks before end of dormancy to the beginning of jointing
- b. Biowindow II - Greening Up - From beginning of jointing to end of booting
- c. Biowindow III - Heading - From start of heading to 2 days after the start of soft dough
- d. Biowindow IV - Yellow - From 2 days after the beginning of soft dough until harvest

For spring wheat the Biowindow I is redefined to 15 days before planting to the beginning of jointing. All other biowindows remain the same.

3.1.3.2 Crop calendar definition. To support the CAMS AI's during Phase I, YES will develop display programs to output mean and adjustable crop calendars in a uniform usable format. This format will be in the form of development stage curves and tabular output which will provide the mean and range of significant development stages and field operations, i.e., planting and harvesting, which will significantly change the appearance of the area being remotely sensed by LANDSAT.

3.2 PHASE I

3.2.1 General Approach

For Phase I operations a subset of the 4,800 sample segments will be analyzed. The distribution of these sample segments is as follows:

<u>Country</u>	<u>Region</u>	<u>Number of segments</u>			
		<u>Spring wheat</u>	<u>Winter wheat</u>	<u>Mixed</u>	<u>Total</u>
U.S.	Great Plains	145	266	—	411
	ITS's*	12	14	1	27
	Selected sites	—	46	—	46
	Remaining sites	8	172	—	180
	Total U.S.	165	498	1	664
Canada	Saskatchewan	170	—	—	170
	ITS's	2	—	—	2
	Remaining sites	9	—	—	9
	Total Canada	181	—	—	181
U.S.S.R.	Selected sites	34	22	6	62
	Penza	—	—	15	15
	Total U.S.S.R.	34	22	21	77
China		8	35	1	44
India		—	35	—	35
Australia		—	15	—	15
Argentina		—	11	—	11
Brazil		—	6	—	6
	Total LACIE Phase I	388	622	23	1,033

*Intensive test sites.

Throughout the duration of Phase I the LACIE data will be collected and analyzed, as techniques and workload permits, according to the priorities specified in section 3.2.1.1 and in accordance with the LACIE operations schedule Phase I (fig. 3-2).

3.2.1.1 Data processing priority. The data will be processed in the following priority:

1. Winter wheat sample segments in the Great Plains region, plus the winter wheat ITS's in the Great Plains.
2. Spring wheat sample segments in the Great Plains region, plus the spring wheat ITS's in the Great Plains.
3. Remaining ITS's.
4. Selected foreign sites in the following priority:
 - a. Canada
 - b. U.S.S.R.
 - c. China
 - d. India
 - e. Australia
 - f. Argentina
 - g. Brazil
5. Selected sample segments in the U.S. regions outside the Great Plains.
6. Remaining U.S. wheat sample segments.
7. Sample segments within the Saskatchewan Province of Canada.

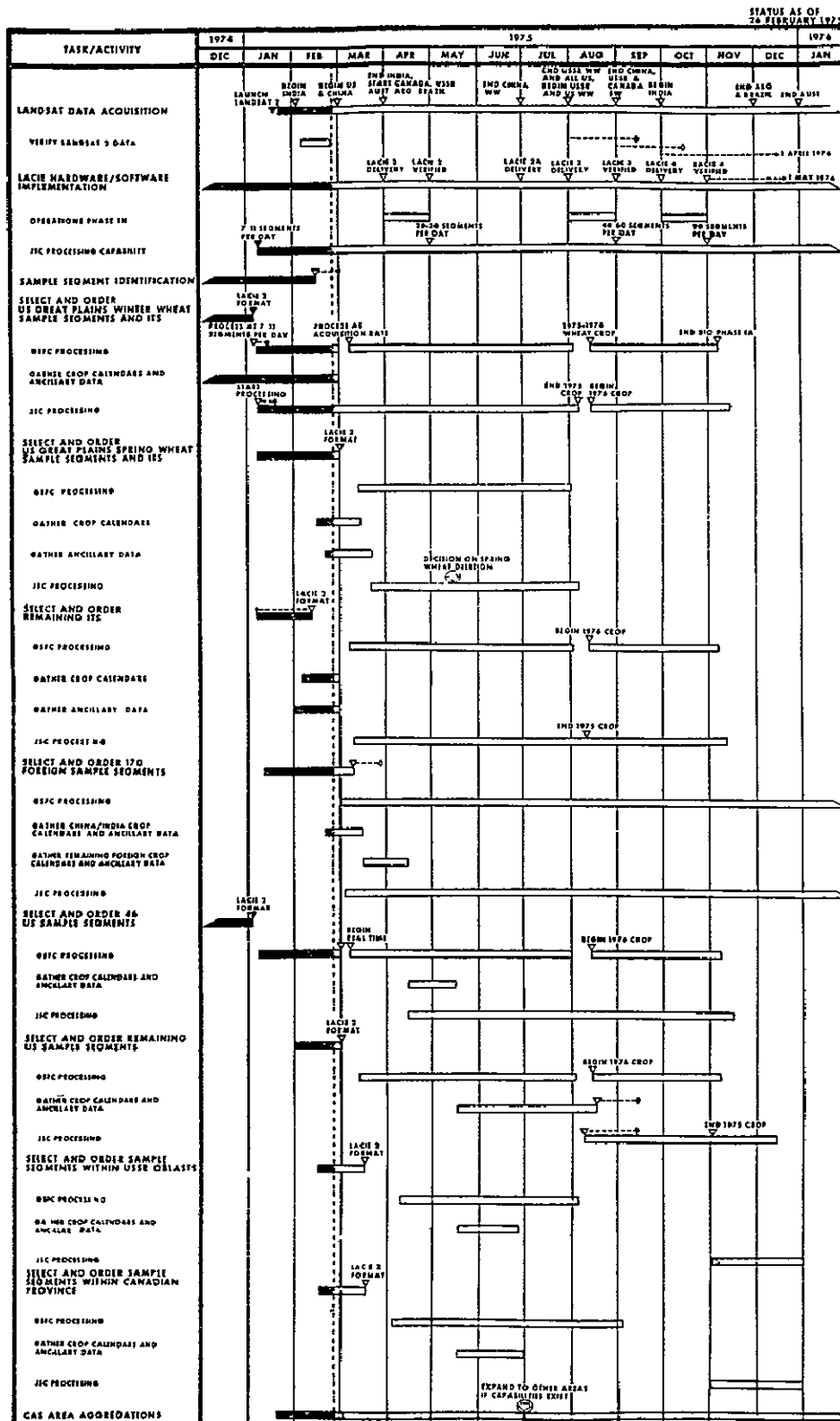


Figure 3-2 - LACIE operations schedule Phase I

3.2.1.2 Phase IA. During Phase IA it is planned to exercise as much as possible, within the constraints of the available resources and the LACIE 1 ADP system, the functional, computational, and operational concepts of the LACIE 2 ADP system, utilizing retrospective data from the LANDSAT over Kansas and Colorado for the 1973-74 growing season. This initial operation is intended to be a system test of the hardware, software, and procedures that concern the processing of the data. The emphasis will be on achieving an orderly data flow through the system.

3.2.1.3 Phase IB. Processing of the full 1974-75 crop year data for the U.S. Great Plains will commence with Phase IB by processing retrospective LANDSAT-1 data for the first biological phase of winter wheat. As the biological window opens in the spring of 1975, real-time acquisitions of data by the LANDSAT-2 will be processed for the remainder of the crop year for spring and winter wheat. During this time, some full-frame data acquired by LANDSAT-1 will be archived as a backup to LANDSAT-2.

The accuracy of the Great Plains area estimates will be assessed using the available Statistical Reporting Service (SRS) data.

Data will also be processed during this phase from the seven foreign countries as they become available from the LANDSAT-2. Data from selected 46 sample segments located in representative U.S. regions outside of the Great Plains will be processed. In addition, support will be provided for T&E during this phase.

3.2.1.4 Phase IC. Phase IC is a continuation of Phase IB but will utilize an upgraded ADP system (LACIE 2) with the processing rate increased to 15 to 20 sample segments per day. Continued support will be provided to T&E with emphasis on yield and production estimation.

3.2.2 Data Acquisition

3.2.2.1 Crop calendars.

3.2.2.1.1 Historical crop calendars: Raw crop calendar data for areas containing sample segments will be acquired from USDA in a standardized format that defines the percent of the area in a development stage at a particular time. A crop calendar is then generated for all major crops in each sample segment and ITS for all LACIE countries. In the United States, this is done at the CRD level. It is generated at a similar level for foreign countries.

3.2.2.1.2 Crop calendar delta: Historic crop calendar data presented as percent area in a given development stage are required by YES from DAPTS which will be used as a base to compute (meteorologically) the current departure from normal crop development and express this in calendar days to produce adjusted crop calendars and biological windows.

The YES will provide support to DAPTS in defining procedures for estimating intermediate crop development stages when historic data are missing and for developing a format for mean crop calendars that is acceptable to CAMS AI's and is computer-compatible. During Phase I, YES will implement a meteorologically driven phenological model to update and make adjustments to the mean crop calendars and biological windows for segments within the U.S. Great Plains and will test and evaluate results in other areas of the United States and Canada. Graphical and tabular displays of the temporal distribution of crop development stages will be computer generated. This information will enable YES to provide guidance to other subsystems (DAPTS, CAMS, and CAS) in making LANDSAT data acquisition, data interpretation, and data aggregation decisions.

3.2.2.2 Ancillary data. Four sets of ancillary data are obtained from foreign and domestic sources. The Cropping Practices Report provides cropping practices data for areas containing the sample segments; these data are collected from the USDA and others by the Country Analysis Group. The Agriculture Statistics Report gives historical

agricultural statistics required for the ITS's and for the 4,800 sample segments over the last 15 years. Two to four topographic map sheets are supplied for each segment in all countries. The U.S. maps are generally supplied in two scales: either 1:250,000 and 1:62,500 or 1:24,000; however, foreign maps may not be to the same scale. Finally, soil maps are obtained for all countries. Copies of each set of data are distributed to the ISRRS library, Regional Analysis, and CAMS.

3.2.2.3 Meteorological data. In support of LACIE, NOAA, in conjunction with the World Meteorological Organization (WMO), will collect, preprocess, store, and transmit the historical, real-time, and satellite meteorological data necessary to develop, test, and operate the crop calendar and yield prediction models. The YES/NOAA will provide these data through a communication data system to other subsystems as required. In addition, YES/NOAA will generate a regularly issued weather summary in hard copy form to provide data and flag episode weather for the JSC subsystems (CAS, CAMS). The DAPTS will receive and catalog the acquired meteorological data that arrives at JSC and will present it to the ISRRS for inclusion in the data base.

3.2.2.4 Regional agricultural reports. The U.S. agricultural reports entitled "Weekly Weather and Crop Bulletin" at the national level and for each state containing sample segments are obtained from the USDA. Reports are also obtained from the Foreign Agricultural Service (FAS) which give a brief monthly overview of a country, generally concentrating on one crop.

3.2.2.5 Data orders for LANDSAT acquisition. Acquisition (and preprocessing) of LANDSAT data will be initiated with the preparation of computer coding sheets. These sheets contain all the sample segment data needed to order data from Goddard Space Flight Center (GSFC).

The coding sheets are formatted as per published LACIE formats and contain segment number, location, training site designation, biological windows, and the color code for PFC. These inputs are obtained from CAMS, YES, and other appropriate subsystems. They are transmitted to Data Systems and Analysis Directorate (DSAD) and used for subsequent preparation of the JSC-GSFC interface tape.

3.2.2.6 ITS data.

3.2.2.6.1 General: There are 27 ITS's in the United States and 2 in Canada. Sampled are winter wheat data from Texas, Kansas, Indiana, and Washington (14 samples), spring wheat data from Canada, South Dakota, Minnesota, and North Dakota (8 samples), and mixed wheat areas (7 samples) from Idaho and Montana.

3.2.2.6.2 Field boundaries and land use: The USDA is the primary source of historical statistical data, including:

- General geography
- Topographic features
- Vegetable cover
- Climatic conditions
- Soil types
- Hydrology
- General culture
- Economic
- Land use
- Agricultural statistics

Field data are used for evaluation and analog signature extension development. These data are collected by USDA over ITS's to support the design, development, and operation of the AES. It includes field boundary locations and field identification.

The Fall Field Identification Report presents data for each field containing fall planted crops in each test site in Kansas, Texas, Washington, and Indiana. The Spring Field Identification Report provides data for all fields in all U.S. and Canadian sites. The inventory is made to be concurrent with the aerial photography of both spring and fall crops. In addition, high-altitude photographic missions are

scheduled once yearly over all U.S. ITS's. Data are acquired from the southern test sites from mid-May to mid-June. The northern sites are photographed from mid-June to late July.

Ground truth data are collected for all ITS's including estimates of stage of growth, plant height, percentage of ground cover, stand quality, and other parameters. Data observations are scheduled in 18-day cycles for approximately 50 fields (25 wheat) in all test sites during the wheat growing season.

3.2.2.6.3 Periodic LANDSAT observations: The LANDSAT data will be acquired over the ITS's at each opportunity during the growing season, preprocessed and shipped to JSC.

3.2.2.6.4 Wheat yield: A yield determination is made from 10 selected wheat fields in each ITS after the wheat harvest. Fields used for yield determination are a subset of the 25 wheatfields monitored throughout the growing season. One set of preharvest information is available on "Wheat Determination Form" after wheat harvest in each test site. Data are based on estimates by observers of the expected yield and quantitative data.

3.2.2.6.5 Optical depth measurements: Atmospheric optical depth correlation with LANDSAT data will be obtained in all U.S. test sites using a solar radiometer. This device will measure the solar intensity at the ground in seven spectral bands overlapping the LANDSAT MSS sensors spectral bands. These measurements will be made within 30 minutes of the LANDSAT passes.

3.2.2.6.6 Data products: The data product outputs from DAPTS are:

- Maps - 1:250,000, 1:62,500, 1:24,000 (or equivalent)
- Aerial photographs
- Overlays

3.2.3 Classification and Mensuration Requirements and Plans

3.2.3.1 Requirements. The CAMS is required to perform the AI and DPA work necessary to accomplish Phase I project objectives. These objectives require that approximately 500 selected segments be processed for up to four biological phases to provide area estimation results for the U.S. Great Plains. Further, approximately 200 to 250 exploratory segments both inside and outside the United States shall be processed for up to four biological phases to identify potential problems and solutions in processing a wide variety of sites and to provide input for deciding upon the expansion of LACIE to foreign countries. U.S. Great Plains and other selected sample segments will be partitioned for signature extension processing such that one set of training segment statistics will be extended for processing of five recognition segments. Finally, approximately 500 runs are planned on the 1974-75 crop year data from the 29 ITS's to provide data to be used in assessing the general accuracy of CAMS classification methods.

3.2.3.2 AI processing plan. Prior to April 1, 1975, all segments acquired shall be interpreted by the AI's. This will require that the standard AI training film products be produced for all such segments.

After April 1, 1975, all acquisitions of the ITS's, the foreign exploratory sites, and the U.S. exploratory sites outside the Great Plains shall be interpreted. In addition, 20 test fields will be selected and field coordinates determined for each acquisition of an ITS.

For segments in the U.S. Great Plains, all segments shall be fully interpreted and complete film sets will be required. Further, for each segment within each signature extension partition the AI shall also provide a set of fields to be entered into the data base as mean level adjustment (MLA) field. The fields to be so entered shall be selected so that the MLA fields from all the segments within the partition belong to the same class.

For all other groups of segments approximately 20 percent of the segments will be interpreted using complete film sets.

3.2.3.3 Operational processing plan. All operational segments shall be processed in batch mode on the first classification attempt. Until April 1, 1975, because of system restrictions on signature extension and clustering, no runs which require such processing shall be completed in batch mode. After this time, upon delivery of a more advanced system, all runs will be made in batch mode unless a particular interactive need exists or appropriate use of time dictates that a run be made interactively.

Before April 1, 1975, all operational segments shall be processed using individual training field statistics. After April 1, 1975, all foreign exploratory sites and representative U.S. sites outside the Great Plains shall continue to be processed using their own training fields. Of the remaining operational segments, 80 percent are scheduled to be processed by signature extension. The 20 percent of the segments to be processed without signature extension are those segments in section 3.2.3.2 for which training fields will be selected. Each of the remaining 80 percent of the segments shall be processed using the training segment statistics for the training segment selected for the signature extension partition in which the segment falls.

Segments in the U.S. Great Plains will make use of signature extension in which signatures are corrected using the MLA obtained by use of the fields selected for these purposes by the AI's as described in section 3.2.3.2. All other segments to be classified by signature extension shall be processed with unadjusted signatures.

3.2.3.4 Accuracy assessment processing plan. Approximately 500 runs will be required to perform accuracy assessment on 1974-75 crop year data from the 29 ITS's. These runs shall begin as soon as adequate ground truth is available to enter necessary test fields into the fields data base. It is anticipated that enough ground truth will be available to begin processing in May 1975 and that completion of these runs shall occur in late August 1975, shortly after the last passes arrive for the segments noted. The following paragraph contains a brief description of the runs to be made.

The 29 sites shall first be divided into nine sets of regional sites and a primary site shall be selected from each set. Using these nine sites, each shall be interpreted

by three different AI's. Then, 108 runs shall be made to assess the general classification accuracy of the different regions and the effect of different AI's and different phases. Using these same nine sites, 162 further runs will be made to assess: (1) signature extension methods, (2) multitemporal recognition, (3) analyst interpretation, (4) site, (5) local recognition, and (6) single phase recognition.

On the remaining 20 sites approximately 250 runs shall be made to further clarify the above objectives. A more complete description of the proposed runs and their purposes shall be published in an accuracy assessment plan.

3.2.4 Yield Estimation Requirements and Plan

The yield estimation requirements during the Phase I test mode are: (1) the developed yield models for selected strata such that the stratum cultural and environmental factors are fairly common, (2) computer hardware/software and communications lines, (3) access to real-time WMO data from the National Meteorological Center (NMC) at Suitland, Maryland, formatted and buffered for insertion in models and storage, and transmission capability of the yield estimates by selected strata, zones, and areas for delivery to JSC YES and CAS.

The plan requires test mode output at least monthly in Phase I of yield estimates for developmental work by CAS and T&E by RTEB.

3.2.5 Crop Aggregation Requirements and Plan

3.2.5.1 Aggregation areas.

3.2.5.1.1 Phase IB: The CAS requires CAMS sample segment classification for the U.S. Great Plains to perform area aggregations of the following:

1. U.S. Great Plains winter wheat area to the stratum level

2. U.S. Great Plains spring wheat area to the stratum level
3. U.S. Great Plains wheat area (winter and spring) to the stratum level

3.2.5.1.2 Phase IC: The areas described in 3.2.5.1.1 will be continued in Phase IC with the following areas being added as data become available:

1. State of Indiana, United States, to demonstrate probability proportional to size (PPS) portion of the sampling strategy
2. All the United States for winter, spring, and combined winter and spring wheat
3. The Penza Oblast, U.S.S.R.
4. The Saskatchewan Province, Canada

3.2.5.2 Aggregation schedule.

3.2.5.2.1 Phase IB: The area aggregations to stratum, zone, and region levels will be made by 30 days after the end of the month of data acquisition, providing CAMS can make a 14-day exploitation of data. This will require approximately 200 aggregations per month. Only test of the yield and production estimate procedures will be conducted for limited areas. The average number of aggregations per day will be 10 with a peak load of 30 per day.

3.2.5.2.2 Phase IC: The operation will be the same as described in 3.2.5.2.1. This will require approximately 700 aggregations per month. Test reports for yield and production will be produced for limited areas in the United States.

3.2.5.3 Production estimation requirements and plan.

3.2.5.3.1 Phase IB: No production estimates will be made during this phase.

3.2.5.3.2 Phase IC: Production estimates will be made for limited areas in the United States, where yield data have been supplied by YES to CAS. The area estimates (3.2.5.1.2) and yield estimates (3.2.4) will be combined to estimate the crop production for test of the interfaces, to test the data processing procedures, and to produce reports for evaluation.

3.2.6 Accuracy Assessment Requirements and Plan

In order to determine the error contribution by each data source, an accuracy assessment will be undertaken which will address each components' contribution. The details of this assessment are given in the November-December Accuracy Assessment Plan and the Phase I Accuracy Assessment Plan. A summary of these plans and requirements is:

In the United States and Canada:

1. The AI errors will be determined in the ITS as compared to ground truth.
2. The ADP classification performance of the CAMS operations will be determined using the ITS for both local training and signature extended cases. This will be done using ground truth. The DAPTS will supply registration errors for each acquisition.
3. Aggregations of wheat area will be made in areas where the density of samples permits. The variance and coefficient of variation of these estimates will be made at the stratum, zone, and region level. Where current year wheat acreages are available, they will be compared to the aggregated estimates. This will be done as a function of biological stage, field size, and segment location.
4. The ADP classification performance in other countries will be tested against AI-identified test fields for wheat and nonwheat. In order to have confidence in this approach, this procedure must be tested in the ITS areas in the United States and Canada.

Items 1, 2, and 4 are accomplished by CAMS and monitored by CAS. Item 3 is accomplished by CAS.

3.2.7 T&E Requirements and Plan

The T&E will require access to the LACIE operating system to carry out the studies discussed below. These studies are in support of CAMS and CAS.

3.2.7.1 CAMS support. The studies in support of CAMS will require the use of the LACIE system to process AES and T&E image data bases and to produce a results data base for off-line processing. The specific studies are as follows.

3.2.7.1.1 Signature extension: The purpose of this task is to:

1. Evaluate the MLA and Sun angle correction algorithms that are to be used in Phase I of LACIE. This will require processing the T&E image data base which contains data from ITS's in Kansas and neighboring SRS sites.
2. Evaluate the CAMS signature extension partitioning procedure. This will require the same data base as in (1) and similar data processing with the LACIE system.
3. Evaluate signature extension procedures that are to be developed by T&E. These include a maximum likelihood method for estimating statistics in extension areas, procedures for estimating the amount of haze in a scene, transformations derived from cluster statistics, and an improved signature extension partitioning procedure. This task will require both the AES and T&E data bases and similar data processing as required in (1).

3.2.7.1.2 Thresholding procedures: The purpose of this task is to test the CAMS procedure for setting threshold values in the classifier and to develop improved procedures. This task will require access to the T&E image data base using the LACIE CAMS algorithms.

3.2.7.1.3 A priori probabilities: The purpose of this task is to evaluate the a priori probabilities as selected by the CAMS procedure. In addition, alternate procedures for selecting probability weights which can be used for priors and which minimize the proportion estimation error will be developed and tested. An image data base consisting of two Kansas ITS's is to be used. The LACIE system is to be the main processing system. A results data base is to be generated for off-line processing.

3.2.7.1.4 Proportion estimation: The purpose of this task is to evaluate six proposed methods for estimating wheat acreage. The task will require the processing of the T&E data base using the LACIE system. All results are to be written onto a results data base for off-line processing.

3.2.7.1.5 Alternate training selection: The purpose of this task is to evaluate the use of spectral clustering as an aid for the AI in the selection of training fields. This task will require the use of four AES AI's and access to the LACIE processing system. The T&E image data base is to be processed and a results data base generated.

3.2.7.1.6 Performance analysis of LACIE operations: The purpose of this task is to develop and test techniques for assessing the performance of the CAMS. This will require that during the operation of the LACIE system that results (classification summaries and/or aggregations) be output for off-line processing and analysis of selected ITS's and selected other segments.

3.2.7.1.7 Alternative AI techniques: The purpose of this task is to develop and test alternative AI techniques which may improve AI performance and/or throughput. This will require access to an AI results data base for selected ITS's and selected other segments. In addition, it may require the use of CAMS AI's for interpretation of selected foreign or analog segments.

3.2.7.1.8 Evaluation of Image 100 for LACIE problems: The purpose of this task is to develop and test techniques and procedures which utilize the Image 100 systems. This will require access to the LACIE image data base and the necessary interfaces implemented to process LACIE data on the Image 100.

3.2.7.2 CAS support. During Phase I, T&E will evaluate the CAS production aggregation procedure. This will require that during the operation of the LACIE system the estimates of acreage at the segment level for Kansas and North Dakota be computed for each of the biological phases that are to be processed. These data are to be written on a results data base for off-line processing by T&E.

3.2.8 Storage and Retrieval Requirements and Plan

3.2.8.1 Ancillary data. Ancillary data will be received from DAPTS and stored in an AI packet in the LACIE Physical Data Library (LPDL). A directory will be maintained for this data to facilitate accounting and retrieval.

3.2.8.2 Maps. The various maps which support the processing of LACIE data are stored in the LPDL. These maps will be stored and retrieved in accordance with the requirements for usage of each map. The maps to be stored are:

1. LACIE sample segment map
2. Strata boundary maps
3. Soil maps
4. Mosaics

3.2.8.3 CAMS AI packets. Data required by the CAMS AI's to interpret the LACIE imagery will be stored in an AI packet. This packet will contain the imagery of the sample segment, crop calendars ancillary data, topographic maps, meteorological data, and a map status form. The map status form will provide information concerning the availability of and the filing status of topographic maps. The AI packet will be indexed and tracked as a single data item; its access will be limited to specific personnel.

3.2.8.4 CAMS DPA packet. The LPDL will provide storage and retrieval of the CAMS DPA packet. This packet will be indexed, filed, and retrieved on sample segment number and biological phase.

3.2.8.5 Classification output products. Statistical summaries and character maps (C-fiche) and menus from pattern recognition (delog) will be received in microfiche format as the result of processing requested on a Data Products Request (DPR). Each set of fiche will be checked for completeness when received. Two sets will be received: One set will be stored in the LPDL; the second is distributed to the requester. The LPDL will maintain a directory of the fiche received.

3.2.8.6 CAMS Classification Summary Report. Classification Summary Reports will be received from the CAMS/DPA and will be indexed and filed within the LPDL. The CAS will be notified of the data availability through the Data Manager Receipt Report.

3.2.8.7 Yield estimates data storage. Yield measurement data will be received from the YES and stored in the LPDL. The data will be indexed and the directory updated prior to its use by the CAS.

3.2.8.8 Meteorological Data Storage. Meteorological data and reports will be received from the YES and stored, retrieved and distributed by the LPDL as required.

3.2.8.9 LACIE remote sensing data. Remote sensing data for LACIE will include LANDSAT imagery and aircraft and helicopter film products. The LANDSAT imagery will be filed in the AI packet; the aircraft and helicopter film products will be indexed and stored in accordance with the indexing parameters provided by the Facilities Support Office (FSO) and the Field Measurements Laboratory. The Data Manager's Receipt Report will advise the appropriate groups of the receipt of the film. Limited access is maintained for these products.

3.2.8.10 GSFC data orders. The DPR will control the flow of computer-coded data orders to GSFC. Computer listings will be received as a result of the generation of a GSFC data order; these listings will be indexed and stored by the LPDL.

3.2.9 AES Operations Reporting

The AES operations will prepare monthly crop area aggregation reports. During Phase I these reports will provide estimations of wheat area over designated LACIE areas.

Accuracy Assessment reports will be prepared which will present the error contribution by each data source to the LACIE results. The details of this effort will be contained in the Accuracy Assessment Plan.

Finally, SPE-EA will publish periodic reports which will, initially, contain a listing of the total resources available and expended for each resource category, for each activity for that reporting period. In addition, the quantity of data processed through each activity will be summarized for the reporting period.

3.2.10 IE Requirements and Plans

The IE will be conducted at the USDA-LACIE headquarters, with prime responsibility within USDA and participation by the NASA and the NOAA. The USDA will be responsible for evaluating the timeliness and utility of area information produced by the LACIE AES.

Specifically, USDA will perform the following:

1. Evaluate the timeliness and utility of area information produced within the LACIE AES.
2. Set forth USDA policy as related to release of area information produced within the LACIE AES

to all organizations or individuals not in direct support of the LACIE AES.

3. Integrate area information produced within the LACIE AES into ongoing operational activities associated with the appropriate functional agencies and services with the USDA.

The USDA will develop a plan for evaluating the timeliness and utility of area, yield, and production information produced within the LACIE AES. This plan will address, as a minimum, the following:

1. The actual procedures to be used in evaluating the timeliness and utility of LACIE wheat estimates, including details as to functions carried on in Washington and at JSC.
2. The type, content, format, and frequency details required to evaluate the LACIE AES results.
3. The statement of USDA policy on release of LACIE information.
4. The USDA guidelines required in handling and storing LACIE information.
5. The evaluation reports which will be provided by USDA as a result of information evaluation.

3.2.11 System Efficiency Requirements and Plan

3.2.11.1 SPE-EA Phase I approach. The SPE-EA will monitor the Phase I operations in order to obtain, record, and report data relating to the operating efficiency of the system with respect to available resources. The system will utilize data which for the most part are presently being collected and documented by the various systems components. The system will be utilized to produce weekly resource utilization reports, monthly summaries for each system component, and baseline information for the LACIE simulation program.

3.2.11.2 Phase I daily throughput information requirements. The information, which is required daily from each of the various system components, consists primarily of the segment numbers (including biological phase) which have been processed by that station that day. Computer times for the major steps involved with the batch and interactive processing will be obtained from delog outputs. This information will be used in the determination of the distribution of throughput time for the various activities. The system operation data will be monitored from the initial data order from GSFC until, and including, the time it is aggregated by CAS into an area estimate. Yield and production information will not be tracked during Phase I.

3.2.11.3 Phase I weekly resource information. In addition to the daily throughput and computer usage information, resources utilized in direct support of LACIE operations will be collected on a weekly basis by each of the major system component accounts. These data will reflect the number and classification of the personnel assigned to support LACIE operations during the reporting period, the amount of processing time utilized, the amount of each category of material expended, and the quantity of data processed for the period. The forms with the specific parameters to be filled out weekly by each component are described in the LACIE Data Handling and Procedures Document.

3.3 PHASE II

TBD

3.4 PHASE III

TBD

4.0 ORGANIZATIONAL RESPONSIBILITIES

4.1 PROJECT MANAGEMENT

Three levels of management are planned for the LACIE with NASA, USDA, and NOAA participation at each level. Figure 4-1 depicts the structure of the organization at the general level. The Project Plan contains a complete description of the management structure.

4.1.1 Executive Steering Group (Level I)

In order to provide management guidance and control of this interagency effort, an Executive Steering Group is established, composed of one appointed member and one alternate from each of the participating agencies. The Executive Steering Group is responsible for the following:

1. Assuring interagency responsiveness on matters of national and international policy communicated via appropriate existing channels.
2. Formulating and approving interagency policies and procedures governing: (1) the conduct of the LACIE, (2) the coordination of the LACIE public information activities, (3) the publication of scientific and technical LACIE documentation, and (4) such subsidiary arrangements as may be required to accomplish the purposes of this agreement.
3. Approving all public information releases pertaining to the LACIE.
4. Securing resources as agreed upon for the implementation of the LACIE.
5. Coordinating and approving, with agency guidelines, any major redirections, changes, extensions, or deletions from the scope of the LACIE.

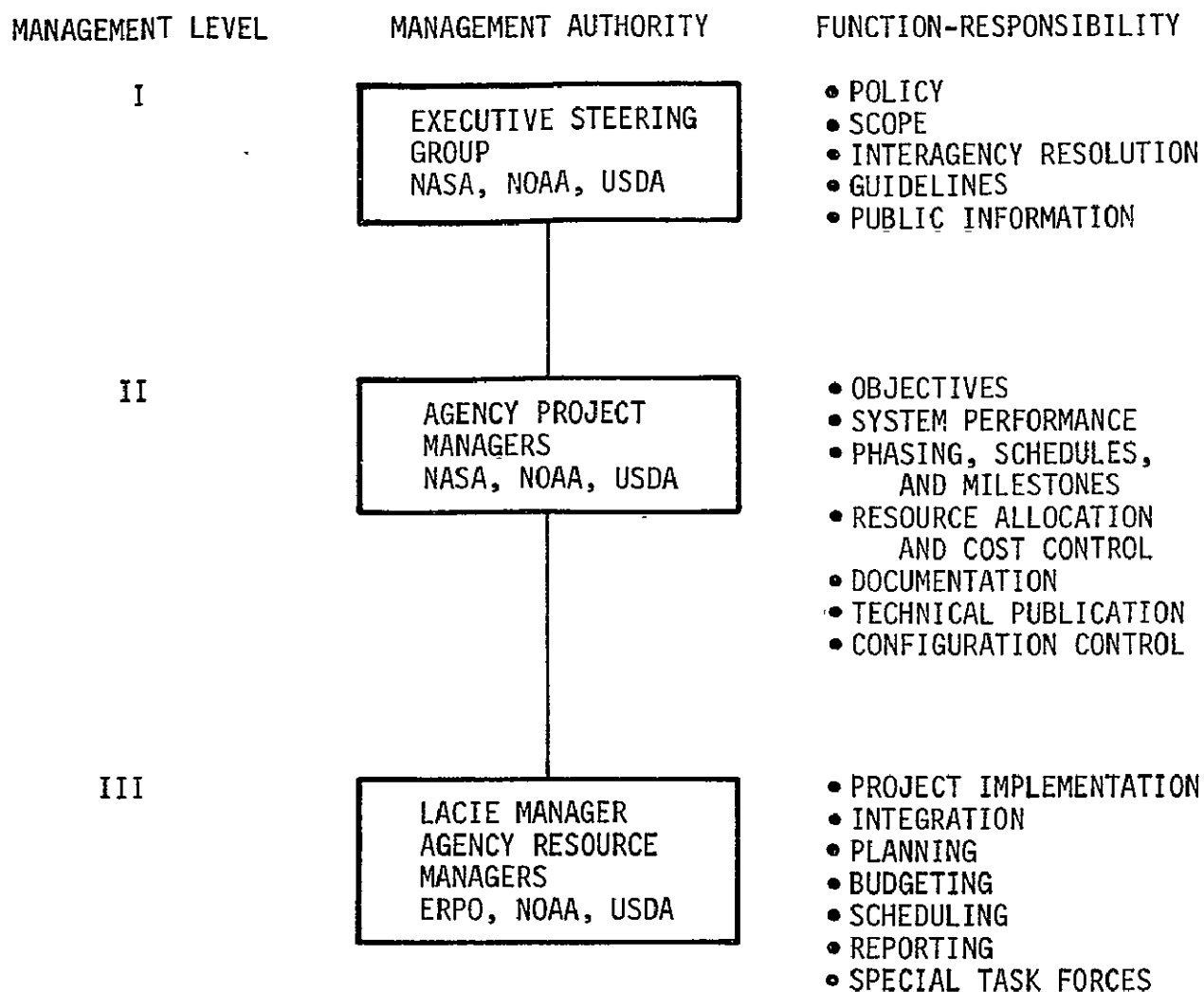


Figure 4-1. — LACIE management structure.

4.1.2 Agency Project Managers (Level II)

In order to focus the technical expertise of each participating agency and to provide an interagency staff for the Executive Steering Group, each agency will appoint a senior project manager. Working together, the Agency Project Managers will have the following responsibilities:

1. Overall management of the fiscal and human resources assigned to the LACIE by the respective participating agencies.
2. Guidance and assistance in the preparation of the LACIE project plans and schedules.
3. Review of the LACIE progress against approved plans and schedules.
4. Approval of scientific and technical publications concerning the LACIE.
5. Coordinating all proposed public information activities and releases pertaining to the LACIE and making recommendations to the Executive Steering Group thereon.

4.1.3 LACIE Manager

The LACIE Manager will be selected by NASA and will be general day-to-day manager of the project. The project management will be centered in NASA facilities at the JSC, Houston, Texas. The NASA, NOAA, and USDA will assign staff support to the LACIE Manager who, under guidance from the Agency Project Managers, is responsible for the following:

1. Integrating interagency activities to meet LACIE goals and milestones and preparing project plans.
2. Preparing necessary budgets, schedules, and reports.
3. Establishing and managing special task forces, as necessary, to examine such problems as yield model selection.

The LACIE Manager will have line assistants, staff, and performing elements in the project organization as shown in figure 4-2.

The joint staff will be totally integrated at the working level under the supervision of the LACIE Manager whether at the JSC or at other locations.

4.1.4 Project Management Team

The Project Management Team (PMT) is comprised of members from the LACIE Manager's technical staff and is under his direction. The PMT provides the technical direction necessary at Level III for the design, implementation, and operation of the LACIE system.

4.2 EARTH RESOURCES PROGRAM OFFICE (ERPO)

The ERPO is the central point of control for all Earth resources activities at the JSC and will determine the requirements, if any, for archiving data at the Federal Data Centers (FDC's). The ERPO will also determine the sensitivity of any data products and define control requirements.

4.3 APPLICATIONS EVALUATION SYSTEM (AES)

The AES is responsible for defining the functional requirements of the LACIE system and subsystems; for designing the algorithms, models, and procedures to be employed; for identifying and mensurating crops; for monitoring the implementation, testing, and verification of the systems; for using the system during the quasi-operational phases; for reporting results from the use of the system; and for executing the support of the RT&E activities. The AES operations organization is shown in figure 4-3.

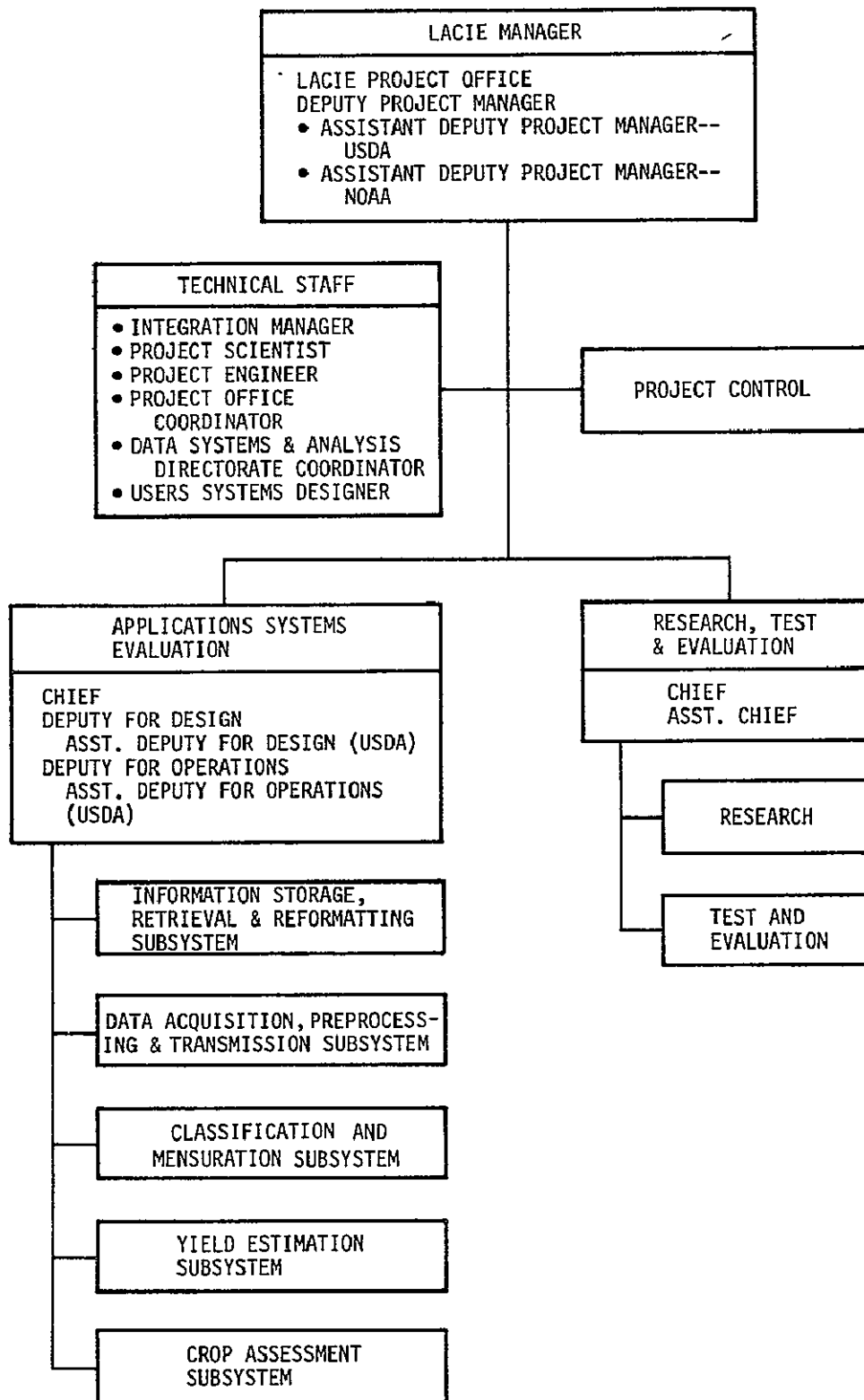


Figure 4-2. — LACIE project organization.

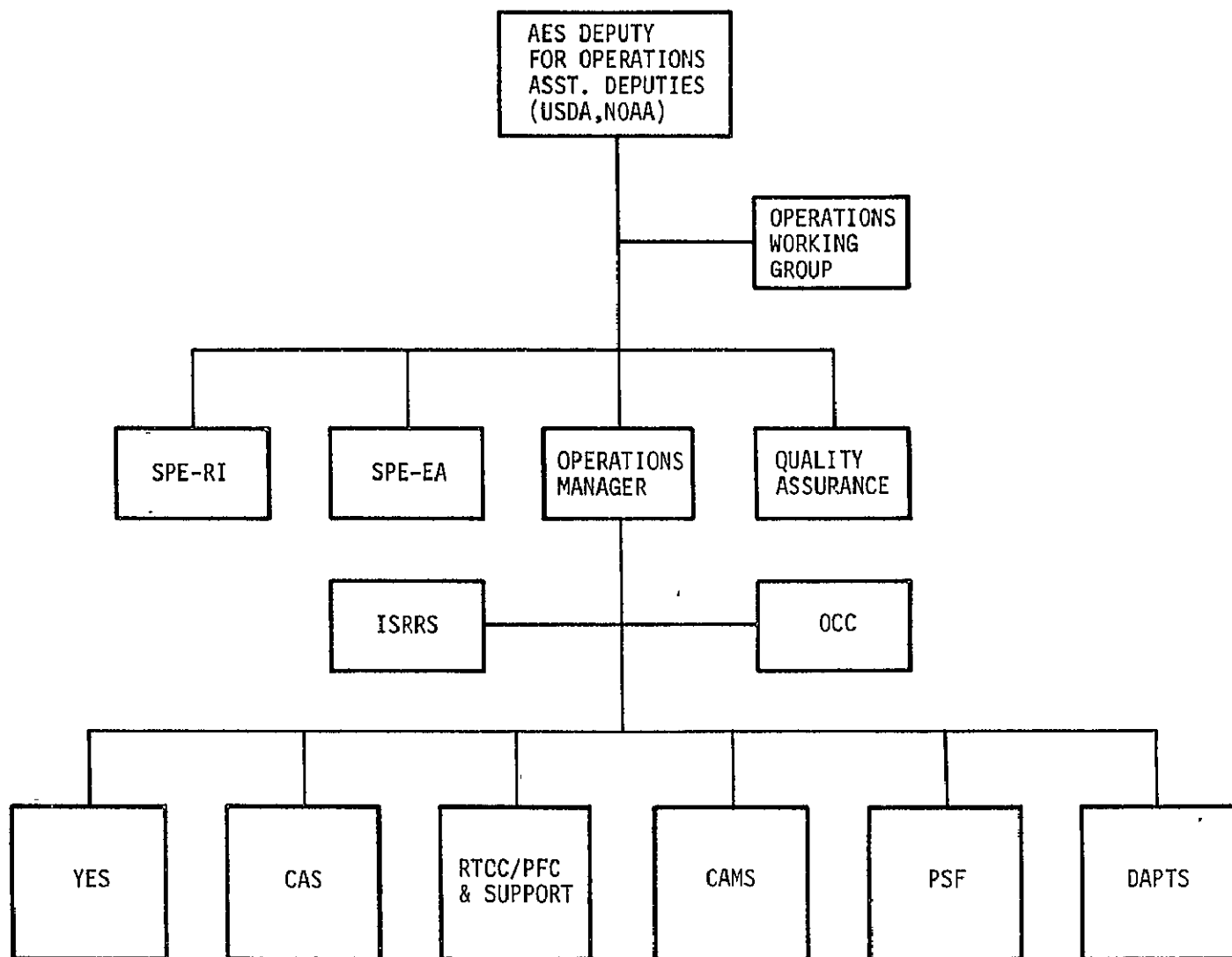


Figure 4-3. — AES operations organization.

4.3.1 Earth Observations Division (EOD)

4.3.1.1 Deputy for operations. The AES Deputy Chief for operations will provide the general management of AES operations. Included will be management of the operational functions of the Information Storage, Retrieval, and Reformattng Subsystem (ISRRS); the Data Acquisition, Preprocessing, and Transmission Subsystem (DAPTS); the Classification and Mensuration Subsystem (CAMS), which includes the Analyst Interpreters (AI's) and Data Processing Analysts (DPA's); the Yield Estimation Subsystem (YES); the Crop Assessment Subsystem (CAS); the System Performance Evaluation - Efficiency Analysis (SPE-EA); and Quality Assurance (QA) activities.

4.3.1.2 Assistant deputies for operations. A USDA and a NOAA representative will man these positions and will support the Deputy Chief for operations in the general management of the AES operations.

4.3.1.3 Operations Manager. The Operations Manager is responsible for directing the activities of the Operations Team. He interacts and coordinates with other AES personnel to insure a processing capability consistent with LACIE objectives.

4.3.1.4 Operations Team. The Operations Team is responsible for carrying out the routine day-to-day LACIE processing operations, including data management, image analysis, data analysis, and operations coordination functions. The Operations Team is comprised of representatives from each of the operational elements depicted on the bottom line of figure 4-3.

4.3.2 Ground Data Systems Division (GDSD)

4.3.2.1 DSAD data integrator. The data integrator is responsible for the DSAD data management function. To fulfill this responsibility, he will establish policy guidelines and direct the activities of DSAD personnel. The DSAD systems integrator will also serve as the principal interface with organizations external to the DSAD for LACIE data production.

4.3.2.2 LACIE data system supervisor (LDSS). The LDSS is responsible for the LACIE operational support in the Real-time Computer Complex (RTCC) on the 360-75 computer. He is responsible for insuring that the software and hardware are working properly, and will bring any discrepancies to the attention of the responsible subsystem manager for corrective action. He will be the primary coordinator for system troubleshooting within the RTCC on production times. The LDSS will also provide the LACIE operations supervisor (LOS) with the status of scheduled jobs, and an inventory of computer tapes produced during production.

4.3.2.3 LACIE operations supervisor (LOS). The LOS is the lead operational position in the GDSD for LACIE data production. All other LACIE support areas are responsive to the LOS. The LOS prepares reports of LACIE production status to GDSD management.

The LOS enforces data production priority guidelines and makes priority adjustments as necessary. This position also is the DSAD coordinator for the LACIE discrepancy report (DR) system, and assures corrective action is taken on all DR's.

The LOS also maintains a status and tracking system to know the whereabouts of all intermediate and final products. This encompasses all activity and movements from receipt of requests to delivery of products to the requester.

4.3.2.4 LACIE data production control analyst (DPCA). LACIE DPCA responsibilities for LACIE are as follows: coordinate with EOD and GSFC on data problems associated with the GSFC Image Data Tape; coordinate with EOD on data products requested and on those requests that require rework; assimilate necessary data and run cards to run each production job; submit RTCC job tickets to the LDSS and work orders to the microfilm facility as required; review each production run to verify successful completion; and, analyze unsuccessful production runs and initiate corrective action.

The keypunch responsibilities for LACIE are as follows: punch and verify the process control cards for each sample segment to be processed; punch, verify, copy, or interpret card jobs as requested by DPR from EOD.

4.3.2.5 Production Film System (PFS) Manager. The PFS manager is responsible for producing LACIE film products from digital data tapes. The PFS manager is responsible for the operation and maintenance of the production film converter (PFC) and the computer output microfiche facility (COMF). He responds to queries from the LOS concerning status of products within the PFS.

4.3.3 Photographic Technology Division (PTD)

PTD is responsible for the photographic processing of the film output of the PFC and processing any other LACIE film products.

4.3.4 Institutional Data Systems Division (IDSD)

The IDSD, which operates the Data Distribution Center (DDC), will be responsible for receiving and distributing data between JSC, GSFC, and other installations involved in LACIE. In addition, DDC will provide on-site courier service, on a scheduled basis, between buildings 8, 30, and 17, for delivery of LACIE data products.

4.3.5 Mission Planning and Analysis Division (MPAD)

MPAD is responsible for the QA of the LACIE data processing system in the areas of data product quality and software performance. In the software development phase, this responsibility includes requirements analysis, software formulation, design certification, software implementation verification support, the development of operational QA procedures, and the development of system input/output (I/O) requirements and off-line software which are required for operational QA support.

In the operations phase, this responsibility includes the assessment of data product quality and the isolation of problems which affect product quality. MPAD personnel also function as consultants in the implementation of software requirements.

4.3.6 National Oceanic and Atmospheric Administration (NOAA)

The NOAA has the prime responsibility for the YES, with support from the USDA and NASA. The yield prediction models will be developed at the Center for Climatic and Environmental Assessment (CCEA) at Columbia, Missouri, and operated by NOAA primarily at the Page building in Washington D.C. The yield estimates and crop calendar adjustments are delivered to the YES manager at JSC for use within the AES. Data will be provided for the Phase I North American Weekly Meteorological Summary prepared by the YES.

The YES manager will be provided by NOAA and will provide general day-to-day management of the subsystem. The YES staff at JSC will include NOAA, NASA, and USDA personnel. YES will be responsible for issuance of the Weekly Meteorological Summaries, issuance of episode weather advisories (normally in the Weekly Meteorological Summaries), crop calendar adjustments and delivery of the yield model outputs in a test mode for selected strata, zones, and areas during Phase I. Stored meteorological data will be provided ISRRS for storage after August 1, 1975.

4.3.7 U.S. Department of Agriculture (USDA)

The USDA is the end user of the LACIE products and as such is responsible for the specifications of needs through a requirements document, the evaluation of the usefulness of the LACIE estimates, and for development of procedures for incorporating the LACIE results in the USDA crop reporting processes. The USDA, because of the requirements for a transferrable system, is responsible for the design of such a system. In addition, the USDA is responsible for the operation of the CAS. The USDA will provide inputs to the sampling strategy for LACIE, ground truth data in intensive test sites in the USDA, and historic agricultural data as required and specified for the various subsystems.

4.3.8 Goddard Space Flight Center (GSFC)

GSFC responsibilities consist of receiving data orders from JSC and sending the corresponding LANDSAT data to JSC.

The LANDSAT data consists of data from the multispectral scanner (MSS). MSS data consists of wideband video data recorded over sample segments specified by JSC. Prior to sending the MSS data to JSC, however, GSFC preprocesses the data. GSFC preprocessing produces 9-track computer-compatible tapes (CCT's). The controlling information, sent from JSC, consists of a CCT and punched cards. Data contained on the CCT will identify the sample segments over which MSS data is to be recorded, the time the data is to be recorded and the CCT format expected by JSC. The specific data formats are contained in the GSFC/JSC interface control document (ICD) for the LACIE.

5.0 OPERATIONS SUMMARY

The flow of LACIE data through the system (figure 5-1) is controlled by this document and by the LACIE Data Handling and Procedures Document. The standard operating procedures for each task to be performed are specified in the LACIE Detailed Procedures Document.

5.1 SAMPLE SEGMENT SELECTION AND ORDERING

5.1.1 Segment Selection

CAS identifies the segment number and the segment position; YES identifies the acquisition windows. These selections are recorded onto a coding sheet which will be used to prepare punched cards and to identify to FSO information to order for the photointerpretation (PI) crop calendars, maps, etc. CAMS will designate the film products desired which will normally be required for 20 percent of the segments.

5.1.2 Segment Ordering

The resultant card deck will be forwarded through FSO to the LOS (building 30) for use in compiling the JSC to GSFC interface tape. The tape listing will be checked and the interface tape will be shipped to GSFC.

5.2 LANDSAT DATA ACQUISITION

These data are acquired by GSFC based on the information supplied by JSC on the interface tape. Raw data from the four-channel MSS is transmitted to the three land sites. The wideband payload video data is received at Fairbanks, Alaska; Goldstone, California; and GSFC Network Test and Training Facility (NTTF) at Greenbelt, Maryland.

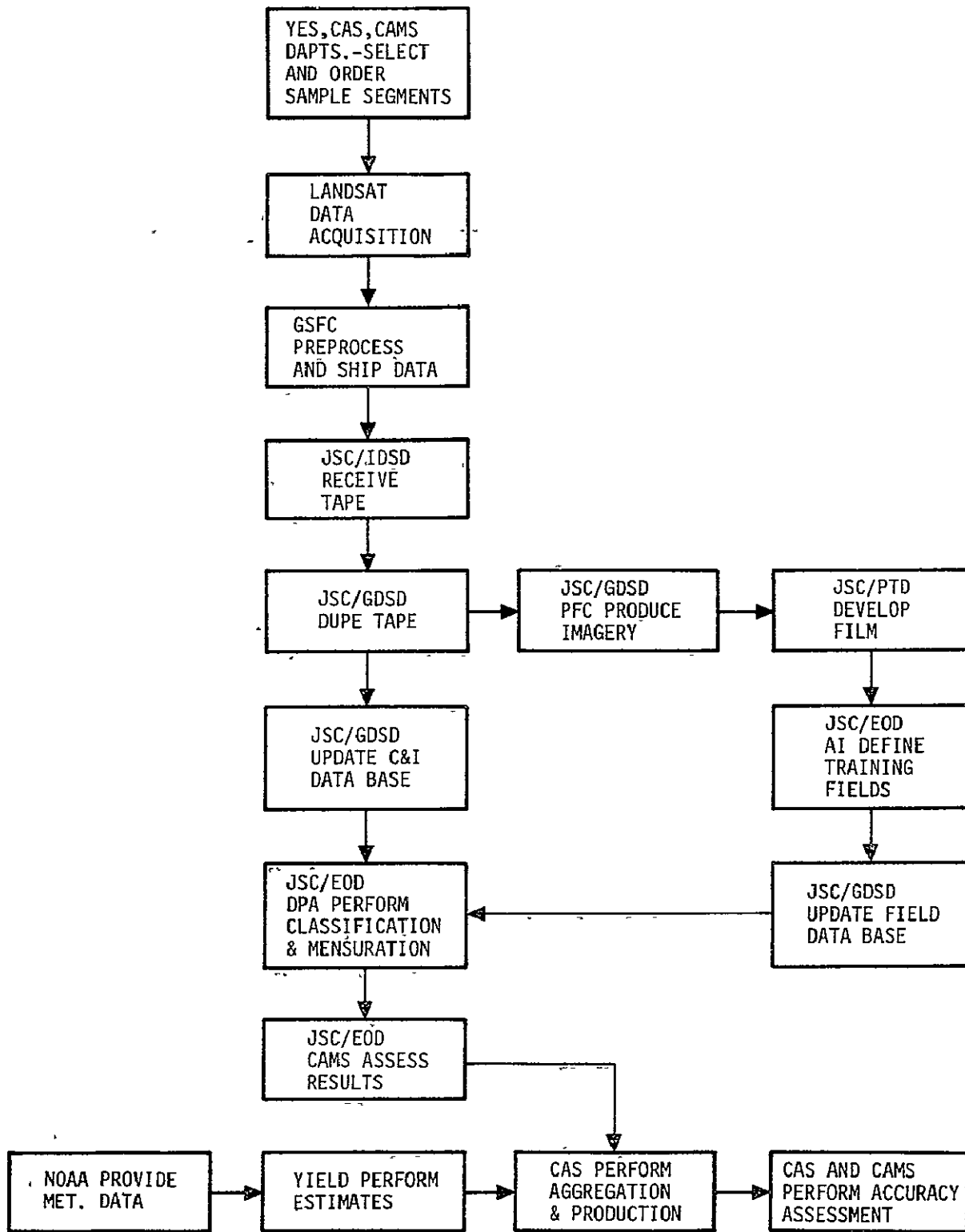


Figure 5-1. - LACIE data flow.

The NASA Data Processing Facility (NDPF) at GSFC accepts payload video data in the form of magnetic tape received in real time at the NTTF station via the GSFC Operations Control Center (OCC) or mailed from Alaska and Goldstone. The NDPF then performs the LACIE special processing and the video-to-film conversion and corrections.

5.3 GSFC PREPROCESSING AND TRANSMISSION

5.3.1 Preprocessing

GSFC will establish a reference set of data for the particular sample segment by extracting the appropriate number of lines and samples from a LANDSAT pass over the designated area. Ephemeris and attitude data will be used to determine the specified location of the sample segment. GSFC will extract the reference sample segment so that the 6 n. mi. edge is parallel to the scan line and the 5 n. mi. edge is parallel to the ground track.

GSFC will identify those portions of subsequent passes specified by the JSC that contain the sample segments, and will extract portions of the record containing the areas of interest.

The new data will then be automatically correlated with the reference sample segment. A transformation polynomial will be generated to transform the new data set into line and sample congruence with the reference data set. The new data set shall correspond to the reference data set in terms of the number of lines and samples. The registration error between each new data set and the reference data set, for the ensemble of pixels in a sample segment, shall not exceed one pixel. This registration step will result in all subsequent data sets for a given sample segment having line sample correspondence to the reference data set; that is, line (1) sample(s) on the n^{th} data set will represent the same point on the ground as line (1) sample(s) on the reference data set. A CCT will be prepared for all new scenes collected within a specified period. This tape will include appropriate header records as specified in the ICD. Format and transmittal of the CCT's will be governed by the ICD.

GSFC will also compute bias and scaling factors for the JSC PFC, and include them in the appropriate location in the header of the ensuing CCT.

5.3.2 Data Transmission

LANDSAT MSS data is transmitted from GSFC to JSC on a 9-track CCT in a strictly defined universal format. It is expected that one or two tapes will be shipped to JSC each day. The MSS data is arranged on the CCT in several files with each file containing data for one site.

Reference is made to the Earth Resources Data Format Control Book, PHO-TR543, for a general description of the universal format and to the GSFC/JSC LACIE ICD for a detailed description of the GSFC image data tape.

5.4 TAPE RECEIPT AND DUPLICATION

Electronic data will be received at JSC by the DDC. Each tape will be logged and sent to the LOS and then copied. One tape will be used to update the Composition and Indexing (C&I) data base and the other will be sent to the PFC for imagery generation.

5.5 COMPOSITION AND INDEXING

The imagery received will be entered into the C&I data base at JSC building 30. A transaction report will be generated and provided to EOD.

5.6 IMAGERY GENERATION AND PROCESSING

The electronic data will be converted to imagery and generated on film in the PFC. The standard products will be produced for those segments which have the film generation flag set by GSFC.

The film will be sent to the Photographic Technology Laboratory (PTL) for developing, sleeving, cutting, and sorting. Then the imagery will be returned to LOS for QA and transmittal to EOD.

5.7 ANALYST INTERPRETATION AND FIELDS DATA BASE UPDATE

The AI's select training fields to be used in the ADP classification operation. The imagery is analyzed by the AI's, who define field boundaries and designate the class names within each of these training fields. The class names and coordinates of the training fields are then entered into the Fields Data Base.

5.8 CLASSIFICATION AND MENSURATION

The CAMS will identify training segments for signature extension. Using training fields supplied by the AI's, the data processing analyst (DPA) will utilize the automatic processing system, both batch and interactive modes, to classify each segment. Results of this classification will be recorded and passed to CAS.

5.9 RESULTS EVALUATION

The CAMS monitors all results which are generated within the subsystem. Following a predefined criteria, results are classified as satisfactory, marginal, or unsatisfactory. The classification is agreed upon by the original analyst and a member of the Evaluation Team.

5.10 YES DATA

Data from the World Meteorological Organization (WMO) will be used to operate the yield models to produce yield estimates for each stratum. These estimates will be provided to CAS to be used for the generation of production reports on selected areas.

5.11 CROP AGGREGATIONS

The CAS shall produce aggregation reports for each stratum, zone, region, and country utilizing analysis results supplied by CAMS. Yield estimates provided by YES will be used to prepare production reports on selected areas for test and evaluation purposes.

5.12 ACCURACY ASSESSMENT

Accuracy statistics will be computed for the zone, region, and country aggregations that will indicate sources of system error and measurement error as well as a computed statistical error.

5.13 INFORMATION EVALUATION

The USDA will evaluate the timeliness and utility of area, yield, and production information produced within the LACIE AES. Provisions will be made for documenting the results of the USDA evaluation of LACIE for the purpose of providing the LACIE AES with: a measure of the relative values of each LACIE information product to the USDA; suggested improvements or changes in format, frequency, accuracy, and precision of LACIE information products; and, recommendations related to the potential utilization of LACIE-type information within on-going operational activities associated with the appropriate functional agencies and services within the USDA.

6.0 DATA MANAGEMENT

6.1 PURPOSE

The LACIE Data Management (DM) group will operate within EOD for the purpose of maintaining a smooth and timely flow of LACIE data and data products through the EOD organization. DM will provide a single point of contact within EOD of all LACIE data, data processing requests, and data statusing.

6.2 FUNCTIONS

Management, statusing and tracking of LACIE physical data and electronic data products will be accomplished through:

- DM review and approval of all LACIE data product requests.
- Maintaining status and location of all LACIE data, electronic and non-electronic, which are in work, in the data bases, and in the archive, through maintenance of an electronic status and tracking system.
- Preparation of reports necessary to show work completed, project data processing and analysis work loads, indicate problem areas, and evaluate LACIE system effectiveness.
- Preparation and implementation of procedures for data requests, data statusing, tracking, and handling within EOD organization.

6.3 OPERATIONS FOR INTERIM SYSTEM

DM is currently supporting LACIE with an interim data management system, utilizing the Interim Status and Tracking System (ISATS), pending the development and implementation of the full-up EOD Status and Tracking System (ESATS). ISATS was developed to use existing and readily available hardware and software permitting maximum satisfaction of the data management functional requirements during the ESATS development phase.

6.3.1 Sample Segment Data Accounting

6.3.1.1 GSFC initialization and update. DM will review, approve, log, and status DPR's generated for the update of the history data base and generation of JSC interface tape. DM will status the update of the history data base and the shipment of JSC interface tape to GSFC. Upon completion of these tasks, DM will provide reports to the LACIE operations manager indicating this status.

6.3.1.2 JSC processing. DM will review, approve, log, and status DPR's for data base updates, generation of film data products, and COM products. DM will maintain a Sample Segment Directory in the ISATS indicating sample segment number, biophase, DPR number, location, date of update, and status for the:

- Update of the C&I data base
- Generation of PFC products
- Completion of the AI sample packet
- Analyst interpretation
- Update of the Fields data base
- Completion of the DPA envelope
- DPA activity
- Completion of the classification summary
- CAS acceptance of the classification summary

DM will provide reports to the LACIE operations manager indicating current status of all sample segments in work.

6.3.2 Data Status and Tracking

6.3.2.1 Data shipment and receipt. DM will status and track all LACIE data and data products; their requests, their

generation, shipment and receipt. To accomplish this, DM will maintain in ISATS three directories; a Sample Segment Cross Reference Directory, a C&I/Fields Directory, and an Interactive/Batch Directory. Additionally, logs will be kept on all data entered and obtained from the LPDL.

6.3.2.2 Composition and indexing. Following the update of the C&I data base, ISATS will be updated to reflect all sample segments/biological phases entered into the data base. ISATS will also log the LPDL receipt of resulting fiche and reports, and be statused to indicate C&I data base update is complete.

6.3.2.3 Imagery generation. Following image generation, PFC products will be logged into the LPDL and ISATS statused to indicate image generation is complete.

6.3.2.4 Analyst interpretation. All data and film products required for the AI segment packet will be logged into the LPDL and ISATS. When all items are obtained, ISATS will be statused to indicate the packet is complete and ready for analyst interpretation. The LPDL will check the packet out to AI and status ISATS accordingly. When analyst interpretation is complete, the AI packet and DPA envelope will be checked back into the LPDL. ISATS will then be statused to show activity is complete.

6.3.2.5 Fields data base update. Following completion of the fields data base update, PFC products and reports will be logged into the LPDL and ISATS statused to reflect activity is complete.

6.3.2.6 Classification and mensuration. The LPDL will log the DPA envelope out to the DPA. When interactive or batch processing is complete, DPA envelope, COM products, PFC products are logged into LPDL. Following classification activity, the classification summary report will be logged into the LPDL and ISATS statused to indicate classification and mensuration complete.

6.3.2.7 Crop area aggregation. LPDL will log the classification summary report out to CAS. After aggregation activity is complete, the classification summary report will be returned to the LPDL where it is logged in and ISATS statused to reflect the sample segment/biological phase analysis complete.

6.4 FULL UP OPERATIONS

DM operations in the full-up system will include all activities described for the interim system, but will become more expanded in scope and have less requirement for manual entries, since the ESATS will have provisions for batch entries and interaction between data bases. ESATS will provide the capability for statusing and tracking all sample segments/biophases from the time sample segments are identified by CAS. It will also provide a significantly increased data base query capability for data contained in the FOD data base.

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7.0 OPERATIONS COORDINATION CENTER

7.1 PURPOSE

The LACIE Operations Coordination Center (OCC) will operate within the Applications Evaluation System (AES) for the purpose of maintaining LACIE operational status, daily analysis operations planning, workload scheduling, problem resolution, and priority assessment. This effort is conducted to assure an efficient and integrated approach to the daily operations effort. The OCC will be operated under the direction of the LACIE operations manager.

7.2 FUNCTIONS

The OCC coordinates each LACIE data acquisition and processing operation. Work schedules are established in cooperation with the operations manager, and data flow through the system is managed accordingly. Production control instructions, requirements, processing parameters, and data base updates are synchronized with system operations; and regular reports on system status and progress toward requirements satisfaction are generated.

The operations representatives utilize the OCC for the purpose of determining status and making operational decisions in terms of scheduling, priority, or troubleshooting assignment. These LACIE operations representatives are from the EOD data manager, the LACIE subsystems, and the analysis teams. The representatives individually make status inputs to the OCC as well as attend daily operations meetings in the OCC. The OCC is operated by the operations manager and his staff, who are charged with overall status maintenance, analysis of status information, flagging problems or potential problems to the operations team, provide periodic production reports, direction, and coordination of LACIE operations activities.

7.3 OPERATING REQUIREMENTS

The OCC functions not only as a facility for providing the operations representatives with a place to conduct daily meetings, but also requires information from representatives to it for effective administration of the LACIE operations activities. The OCC activity and the daily meeting are not intended to be problem solving functions; however, they do serve the function of revealing problems and making the action assignments necessary to their solution. It is anticipated that the operations representatives will have the necessary information prepared prior to each day's meeting and that the operations meeting will be a very short evaluation of this information resulting in establishment of the daily schedule, assignment of priorities and assignment of action for the solution of specific problem areas. Once the operations meeting is over, those persons assigned actions will be assisted by OCC personnel when necessary in the gathering of information or researching files. OCC personnel, however, will not necessarily become involved in the technical aspects of problem solving.

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8.0 RECORDS MANAGEMENT

8.1 GENERAL GUIDELINES

To be supplied by ISRRS.

8.2 ARCHIVAL STORAGE

To be supplied by ISRRS.

8.3 TAPE LIBRARY STORAGE

To be supplied by ISRRS.

8.4 REPORT STORAGE

To be supplied by ISRRS.

9.0 QUALITY ASSURANCE

QA will monitor the system to ensure that operations activities are performing as specified. This applies to varying items, such as, testing of operational systems, checking imagery, etc. Each subsystem or organization involved in LACIE has some quality assurance task they are performing. Performance of these QA tasks will be integrated in the LACIE Quality Assurance Plan.

10.0 SECURITY

To be supplied.

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